STANDARD AUTONOMOUS FILE SERVER
SAFS

Project Management Plan

Version 1.1

August 25, 1997

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1.0 Introduction

The purpose of the Standard Autonomous File Server (SAFS) effort is to create an operational system which will provide automated management of large data files which are the result of mission specific data functions. In addition, the SAFS will provide customers access to these files in a timely fashion without interfering with the assets involved in the acquisition and processing of the data. The purpose of this document is to describe the approach to be taken to accomplish this effort and to describe the highest level requirements to be met.

1.1 Applicable Documents

Data Distribution Facility (DDF) Data Distribution System (DDS) Consumer System Users Guide	CSC 100318211
ADEOS-II Network Communications Interface Control Document	EOIS.AII-ND-009
ADEOS-II Network Communications Interface Requirements Document	EOIS.AII-ND-008
ADEOS-II Ground System Interface Requirements Document	AD2-EOC-96-056

1.2 Overview

The ADEOS-II working group initiated the SAFS project, which will be a separate effort from ADEOS-II, but will be supporting ADEOS-II, among others, as its first customers.

The SAFS system will be an autonomous intermediary between ground stations and their data customers who have requirements that can not be managed by media distribution. It will benefit the customers, whose systems usually lack the robustness required to handle unsolicited data transfers from increasingly automated ground stations. It will also benefit the operational ground stations, which are usually not well equipped to handle non-real time, non-operational interactions resulting from customer systems' data requests. The SAFS system will use standard protocols and COTS products wherever possible as it ingests and manages down linked data, while enhancing reliability and preserving autonomous file handling from customer systems where required.

The benefits from the use of the SAFS system will be increased data distribution in a more flexible, reliable and timely fashion, as well as additional automation of ground station activities. The SAFS system will also have merit in an operational range environment to give experimenters and other relevant personnel access to raw vehicle data without interfering with the operation of range systems. By using standard protocols and COTS products wherever possible, the SAFS system could be a standard resource in any large transaction based system in which the data source is real time and time-constraints dictate non-interference by external access.

1.3 Key Personnel

SAFS project lead	Susan K. Semancik	Code 822
AWOTS project lead	Thomas J. Pittman	Code 822
EPGS project lead	Alan R. Selser	Code 822
ADEOS-II project lead	Ronald G. Forsythe	Code 822
ADEOS-II Data Stripper lead	David J. Lassiter	Code 822
Computer Network lead	Carl E. Johnson	Code 822
Engineering and Operations Interface lead	David J. Lassiter	Code 822

1.3.1 SAFS Project Lead: Susan Semancik, Code 822

The SAFS Project Lead is responsible for the planning, design, and development of the SAFS system in accordance with project requirements, including overseeing software development, hardware and software procurement, and system testing. This lead must work closely with

- Project leads to ascertain requirements that might affect the design and/or operation of the SAFS system,
- the Computer Network Lead to determine network requirements that might affect the system design and/or performance,
- the Data Stripper Lead to establish file transfer requirements between the data stripper and the SAFS system, and
- the Engineering and Operations Interface Lead during the installation and testing of the SAFS system in the field.

1.3.2 AWOTS Project Lead: Jay Pittman, Code 822

The AWOTS Project Lead is responsible for reviewing the progress, status, and proposals from the SAFS lead to determine that they meet the requirements for the immediate as well as near-future missions, and to advise when deficiencies, inaccuracies, or problems are apparent.

1.3.3 EPGS Project Lead: Alan Selser, Code 822

The EPGS Project Lead is responsible for reviewing the progress, status, and proposals from the SAFS lead to determine that they meet the requirements for the immediate as well as near-future missions, and to advise when deficiencies, inaccuracies, or problems are apparent.

1.3.4 ADEOS-II Project Lead: Ron Forsythe, Code 822

The ADEOS-II Project Lead is responsible for reviewing the progress, status, and proposals from the SAFS lead to determine that they meet the requirements for the immediate as well as near-future missions, and to advise when deficiencies, inaccuracies, or problems are apparent. In addition, this lead is responsible for providing the requirements of the ADEOS-II mission for the SAFS system, and will work closely with the SAFS Project Lead in developing a testing plan to determine whether the SAFS system meets its functional and operational requirements before the ADEOS-II launch.

1.3.5 ADEOS-II Data Stripper Lead: Dave Lassiter, Code 822

The ADEOS-II Data Stripper Lead is responsible for the dissemination of requirements and capabilities of the ADEOS-II data stripper as it affects the design and operation of the SAFS system. In addition, this lead is responsible for providing data during the testing phase to verify the communications and file transfer requirements are being met between the data stripper and the SAFS system. This lead will also be instrumental in helping to design failure procedures, reporting routines, and other operational procedures that affect the SAFS system.

1.3.6 Computer Network Lead: Carl Johnson, Code 822

The Computer Network Lead is the NASA WFF point of contact for the design and implementation of communications networks internal to WFF and for the integration of internal communication networks with the larger NASA communications network.

1.3.7 Engineering and Operations Interface Lead: Dave Lassiter, Code 822

The Engineering and Operations Interface lead is responsible for facilitating a smooth transition of engineered products to an operational environment. This includes coordinating the technical support necessary to perform the actual installation of equipment, cables, and other support necessary for the full installation and testing of the SAFS system.

2.0 Technical Approach

A number of technical decisions need to be made concerning the design of the system, its interaction with the systems acquiring real-time data, and its interaction with the customer base for the ADEOS-II project, with enough flexibility to provide for the customers of future projects. Some of the information needed for these decisions should be forthcoming from the July 1997 ADEOS-II meeting in Japan. Based on the currently available information, the following assumptions have been made:

1) The SAFS system will not be considered a part of the ground station and will be on an open net outside of the NASCOM "closed-net"; the use of firewalls between the SAFS system and the ground station is not part of the design of the SAFS system.
2) Data compression, file splitting, data encryption and other file transformations are not required of the SAFS system.
3) For nominal operations, no human interaction will be required for file acquisitions, file transmissions, email transactions, disk management, or performance reporting.
4) The SAFS system should be able to process data files with sizes of up to and including 540 MB.
5) The SAFS system is not expected to be an archival system for mission data, as files will be deleted after delivery or when age requirements are met.
6) Processing estimates are based on the SAFS system being dedicated to supporting a single mission.
7) Processing estimates are based on at least a T1-connection between the SAFS system and its customers.
8) SMTP will be used to handle email notifications between the SAFS system and its customers.
9) Some customers may require the ability to "pull" their data files from the SAFS while others may choose to gain improvements through other techniques provided to them.

There are two main models for the design approach under consideration at this time. Once a decision has been made as to the type of design approach to take, then scripting files will be developed or COTS products will be used to automate the operations necessary to meet the requirements of the SAFS system. Testing will be performed on a prototype of the SAFS system in a lab environment before the system is installed and tested in the field at the affected ground stations. A plan will be developed for accomplishing the testing of both the prototype and field versions of the SAFS system. In addition, the following will be addressed:

1) Performance management with respect to problem reporting, throughput inadequacies, and fail-over action;
2) System administration and maintenance:
    a) Who will be the contact for customer questions/problems after acceptance?

b) Will the delivered system(s) be under a maintenance contract? If not, who will be responsible for maintenance?

3) Configuration control:
   a) Who will accept the final product?
   b) Who will conduct the acceptance testing?
   c) Will there be a configuration control board for incorporating changes to the system after it has been accepted?

2.0.1 Model 1

Figure 1 indicates a preliminary approach to managing data access to customers through the SAFS. It relies on email for data availability notices, and acknowledgements of data receipt, with the customer "pulling" the data from the server when notified of its availability. The major drawback with the adoption of this model is that customer-driven access of data files can seriously impact the timeliness of data transfer, since the SAFS system must wait for an indeterminate amount of time before the customer initiates the data transfer. Also, using standard FTP for large file transfers can cause large delays since error detection or disconnection during transmission can result in the retransmission of the entire file, even if only a small part of the transferred file has an error or is missing. Even error-correcting applications of FTP that rely on roundtrip acknowledgements per buffer transmission can result in transfer delays and inefficiencies. Because of these possible delays, some thought is being given to subdividing large files into smaller files for transmission, but it has not yet been decided whether this should be done on the server side or the data acquisition side.

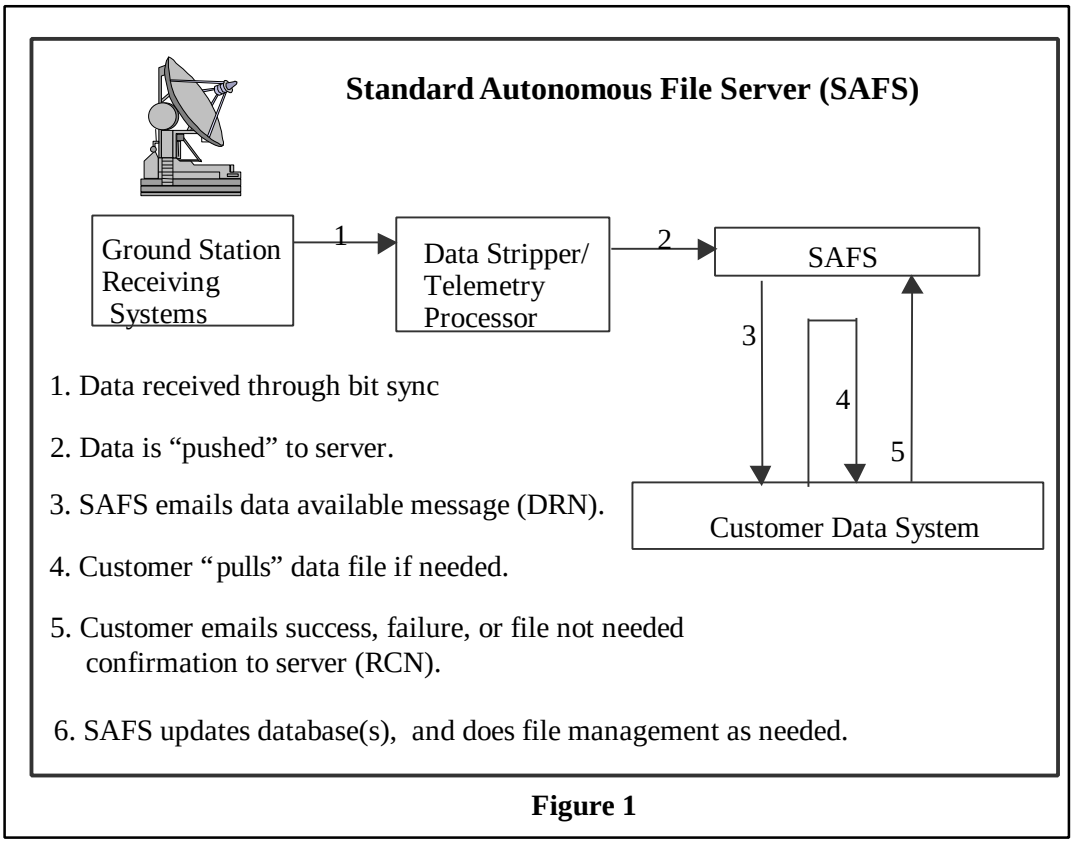

Figure 1

2.0.2 Model 2

There are several COTS products available that minimize the time bottleneck in self-correcting transmissions by minimizing acknowledgement traffic and alleviating the need to re-send entire files due to transmission errors or disconnections. In addition to this checkpoint/resume capability, there is a COTS product that will also multicast the file transmission to multiple customers, using one transmission on a multicast address, thereby providing the ability to send at a full bandwidth rate to any number of customers who receive the file simultaneously. The literature from StarBurst, the vendor of multicast FTP (MFTP) states:

> "StarBurst Multicast is a multi-platform, cross-platform client/server application [available on various platforms which can coexist in the network]."
>
> "StarBurst MFTP is the approach that makes most sense for the electronic dissemination of information from one to many recipients. It takes advantage of new network services such as multicast frame relay, multicast SMDS, and multicast IP. And it is optimally efficient, as the transmitter does not wait for acknowledgements before transmitting. It is delay insensitive and only bad or missing frames are resent. The transfer rate is explicitly settable, preventing a large file transfer from hogging the whole network and preventing other network applications during the transfer. "
>
> "Each StarBurst Multicast session includes three phases: announce/registration, data transmission, and completion [notification]. Prior to sending files, the software multicasts a message to a group of pre-determined recipients, informing them data will be transferred at a certain time. The recipients then register to receive the information. During data transmission, files are broken into blocks and frames and sent across the network to each recipient simultaneously. A block consists of multiple frames. As lost or bad frames are recorded by the receiver, the software requests retransmission of only lost or bad frames on a block by block basis [at the end of a pass through the file] using StarBurst Multicast's efficient negative acknowledgment scheme. The sender then sends only the frames that receivers have requested to be retransmitted on subsequent passes through the file. Once the entire file reaches its destination successfully, each receiver notifies the sender the transfer is complete."
>
> "The StarBurst Multicast application includes client and server components, with both command line and graphical user interfaces. The software provides several key features and benefits, including operational efficiency, bandwidth conservation and a checkpoint/resume capability. Because StarBurst Multicast does not require tight synchronization between senders and receivers, it can run over networks of all types and speeds, regardless of round-trip delays. Therefore the application can work over high-delay satellite networks as well as high-speed local-area networks. StarBurst Multicast also enables senders to adjust the data transmission rate, specifying the bandwidth to be allocated for the file transfer, conserving bandwidth. Finally, the software's checkpoint/resume capability saves time by automatically resuming interrupted transfers without requiring the sender to start the entire process over again."

With this technique, time could be saved by simultaneously sending the same data to several clients. Also, this approach would eliminate the need to subdivide large files into smaller files for retransmission. By polling the client list, the SAFS could immediately send files to those customers able to receive them, without incurring delays due to email requests. Periodic polling could then trigger the sending of the file to those not available for the original transmission. This model is illustrated in Figure 2, and deserves more scrutiny as it seems to give the best blend of reliability, and timeliness with "push" technology, while still preserving autonomous file handling from customer systems where required.

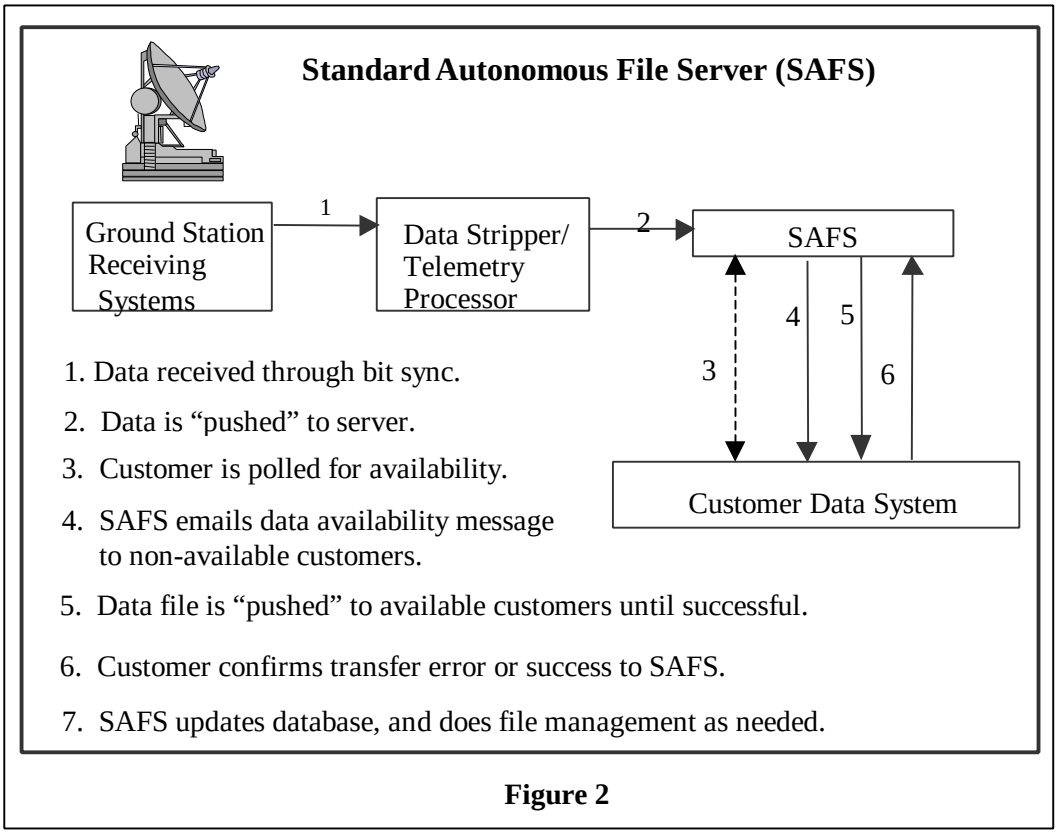

Figure 2

2.0.3 Functional Specifications

The following are the functional tasks that have been determined for the SAFS system:

1) pre-setup tasks
   a) Create requestor database, which will include for each requestor, its name, number of files expected, names of expected file, age condition to be met before deletion without successful transfer, priority for transfer, and delta-time slot for time between availability and successful transfer.
   b) Create a file database with slots for file name, date/time received, date/time deleted, and number of successful transfers.
   c) TBD: will there be a need for a user interface for changes to either database?

2) Ground Station tasks
   a) receive data through bit sync
   b) data stripper packs data into file(s)
   c) data stripper "pushes" file(s) to SAFS system

3) SAFS tasks
   a) update file database with availability time on receipt of file from ground station
   b) i) Model 1: cron jobs
      (a) When detect file received from data stripper, send email to requestor(s) of file about its availability = data ready notification (DRN).
      (b) If receive email acknowledging file receipt (RCN), delete file if no other requestor needs the file, and update file and requestor databases.
   ii) Model 2: use Starburst Multicast software to do the following:

(a) Query intended recipients of file to see if they are available.
(b) Simultaneously MFTP file to available recipients.
(c) Re-send any parts of the file that are indicated as bad or missing by a recipient until all recipients' Starburst Multicast software acknowledge a successful transfer or until file has met age requirements.
(d) Use a cron job to do the above procedure for any unavailable recipients until file has met its age requirement.
(e) Update file and requestor databases accordingly.

c) Delete any file meeting deletion or age requirements, and update the file database accordingly.
d) TBD: Should there be a status report screen available on user request or posted to an Internet site showing the file and requestor database information and amount of disk space available?

4) Requestor tasks
   a) Model 1
      i) When email is received that a requested file is available, "pull" the file from SAFS.
      ii) Email error, success, or file not needed confirmation to SAFS = receipt confirmation notification (RCN).
   b) Model 2
      i) System to receive file is turned on.
      ii) Starburst Multicast software has been activated as a background task (this can be automatically accomplished when the system is booted).

2.1 Management Approach

The manpower employed to support this effort will be drawn from Wallops Flight Facility, Code 822, and the contractor personnel supporting that group. It is anticipated that this project will team 1-2 contractors with one civil servant. This project is among the projects of highest priority that are supported by that workforce, with the exception of launch critical modifications to systems supporting scheduled WFF launch campaigns. The most crucial driver of this effort is schedule. Reuse in other ground station and launch support systems is a secondary driver.

3.0 Requirements

The SAFS system will operate with a high degree of autonomy such that nominal operations will require no human interaction for file acquisitions, file transmissions, email transactions, disk management, or performance reporting.

Satisfaction of ADEOS-II and other mission-specific requirements as defined in those missions' DMR documents with respect to file acquisition is required

TBD: Must the deliverable system be in a rack-mounted form or will a desktop or tower arrangement be acceptable?

3.1 Project Structure

The SAFS project lead will report progress, status, and proposals to the EPGS project lead and to the AWOTS project lead. In addition, the project lead will coordinate activities with the immediate customer project, ADEOS-II.

TBD: What kind of timetable is mandated for progress and status reports?

4.0 Milestones and Schedules

The following functions need to be performed in order to implement an operational SAFS system:

FUNCTION	ACCOMPLISHMENT DATE
1) determine applicable hardware and software requirements for ADEOS-II support	By 8/31/97
2) evaluate applicable COTS products	By 8/31/97
3) conduct a design review for the intended implementation	By 8/31/97 (All dates after this are based on this starting date.)
4) setup a prototype system in a lab environment	By 9/30/97 (depends on selection and availability of data stripper)
5) develop scripting files to automate processes for SAFS system	By 10/31/97
6) test prototype system	By 11/30/97
7) procure system for each affected ground station: AWOTS and AGS	By 5/31/98
8) at each affected ground station, field install a SAFS system with required data stripper and network in place	By 8/01/98
9) field test at each affected ground station	By 12/31/98

5.0 Funding

Funding for this project will originate from the 314 60 60 budget, AWOTS budget, SGS/AGS budget, and ADEOS2 budget.

5.1 Overall Costs

The chart below shows the overall costs of the SAFS effort broken into major categories of equipment, labor and infrastructure. These estimates will be affected by design choices, use of COTS products, and determination of other factors in the review and prototyping processes.

EQUIPMENT			**Labor**			**Infrastructure**		
Computer			HW Installation Labor			Racks, cables, etc		
Hard drive(s)			Software Labor					
Cots products: MFTP system Disk Mgt. SW								
Prototyping system								
Subtotal			Subtotal			Subtotal		

						TOTAL COST:		

6.0 Product Assurance

A number of methodologies will be used to insure compliance with requirements. Beginning at the lowest level, the following methods will be used

6.1 Module and Component Testing

Each hardware or software component submitted or procured for integration into the SAFS system will be subjected to verification and validation procedures to insure compliance both with operation requirements and project requirements.

Prior to delivery, a prototype system, including hardware and software, will be tested in a lab environment in WFF, Building N161. Operation in that lab will be used to evaluate performance and to obtain feedback from key personnel with engineering or operational background.

Installation of the SAFS system will be tested and verified under the direction of the Engineering and Operation Interface Lead who will insure compliance with requirements in the ADEOS-II environment and will direct the use of the system in network and mission test scenarios.

6.2 Review

A requirements/design review will assess the completeness, clarity, and correctness of the SAFS system implementation with respect to ADEOS-II Project requirements, as well as the specific system design and implementation plan for long-range use. The review will insure that implementation strategies and designs make maximum use and reuse of COTS and other available off the shelf systems.

6.3 Configuration Management

Configuration management procedures will be applied to all components delivered or developed during this effort and will be base-lined as of the start of the project. Subsequent builds or deliveries will result in incremental versions of the SAFS system in any or all functional areas. Changes to archived software or installed software following the initial delivery will require approval of the SAFS Project Lead prior to the system being accepted for integration.

7.0 Risk Management

There are a number of risk factors associated with this effort. Management of these risks is the responsibility of the Project Lead in conjunction with the other members of the implementation team. In general there are programmatic and technical risks of varying degrees of severity. Major risk areas are identified, classified with respect to severity, and an approach to minimizing the risk is described.

7.0.1 Requirements

A detailed requirements' analysis of the specific missions to be supported by the ground stations and the requirements of their customers does not fully exist. As such, it is possible that SAFS system procedures or specifications may not be able to meet all future missions. A regular review of mission requirements with respect to the SAFS system's operation should address this problem in sufficient time to correct or expand its functionality or specifications.

7.0.2 Interfacing

A change in either the data stripper or network environment can adversely affect the performance of the SAFS system. These systems should also be under a configuration control board that will review the impact of such changes on the SAFS system.

7.0.3 COTS Products

It is important to note that concerns over the use of a COTS product include not only the robustness and appropriateness of the product for the current application, but also the viability of it's company for the life-cycle of the project for which it will be used. Also, COTS products should exhibit enough forward-thinking design as to be viable for long-range applications, but should be tested enough in the public arena as to be trusted for mission-critical and/or sensitive applications.

8.0 ABBREVIATIONS AND ACRONYMS

The following alphabetized list contains the definitions of the abbreviations and acronyms used in this document:

ADEOS	Advanced Earth Observing Satellite
AGS	EPGS in Alaska
AWOTS	Automated Wallops Orbital Tracking Station
COTS	Commercial Off the Shelf
DMR	Detailed Mission Requirements
DRN	Data Ready Notification
EOS	Earth Observing Satellite
EPGS	EOS Polar Ground Station
FTP	File Transfer Protocol
IP	Internet Protocol
MB	MegaByte
MFTP	Multicast FTP
NASA	National Aeronautics and Space Administration
NASCOM	NASA Communications Network
RCN	Receipt Confirmation Notification
SAFS	Standard Autonomous File Server
SGS	Svalbard Ground Station
SMDS	Switched Multi-megabit Data Service
SMTP	Simple Mail Transfer Protocol
TBD	To be determined
WFF	Wallops Flight Facility